

NATIONAL BUREAU OF STANDARDS REPORT

4463

**Current-Intensity, Voltage-Intensity, and Current-Voltage
Characteristics of Runway- and Approach-Light Lamps**

By
Photometry and Colorimetry Section
Optics and Metrology Division



**U. S. DEPARTMENT OF COMMERCE
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NBS PROJECT

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By
Photometry and Colorimetry Section
Optics and Metrology Division

Prepared For
Visual Landing Aids Branch
Airborne Equipment Division
Department of the Navy
and
Equipment Laboratory
Wright Air Development Center
Department of the Air Force

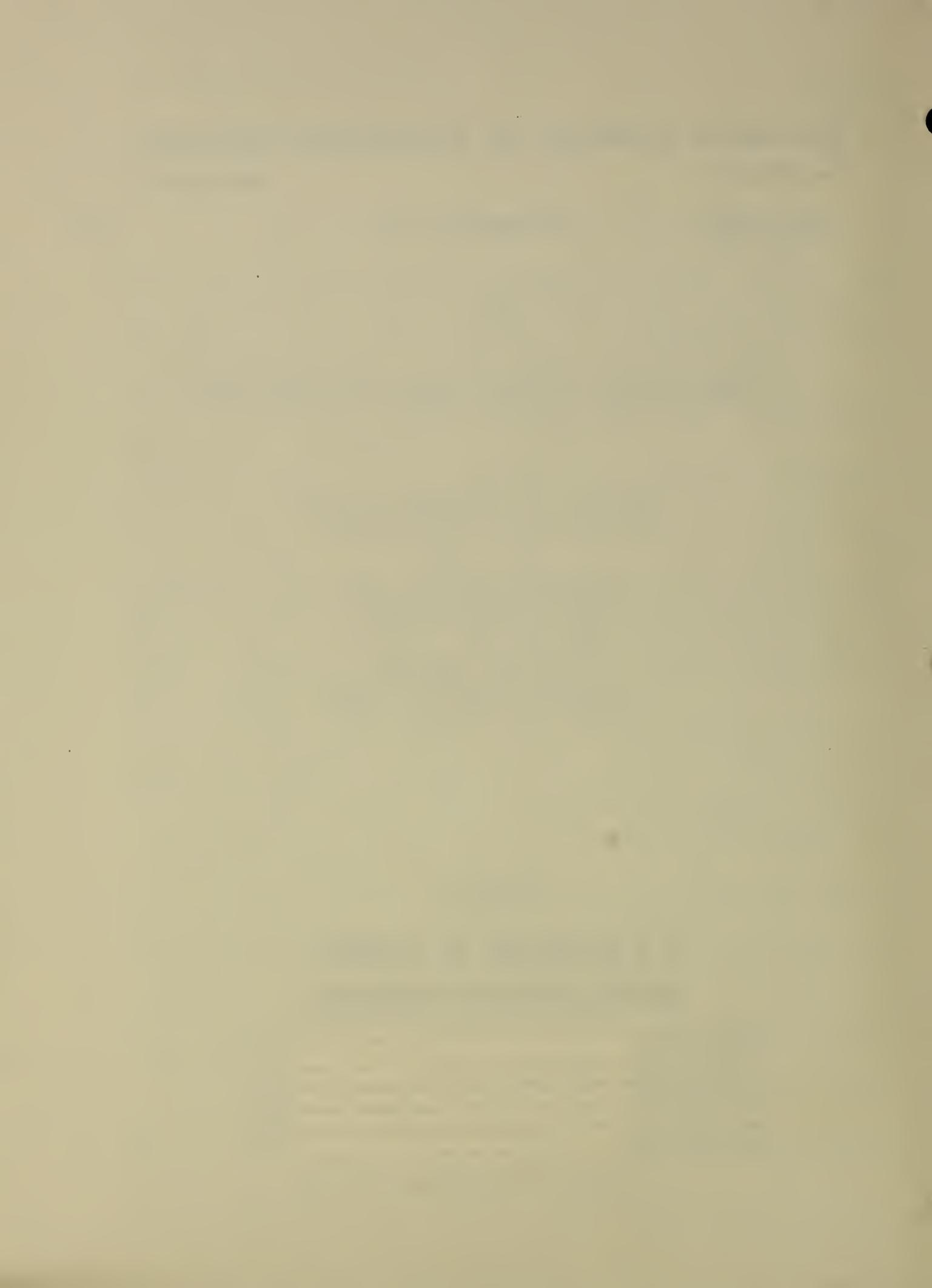


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Report on the
Current-Intensity, Voltage-Intensity, and Current-Voltage
Characteristics of Runway- and Approach-Light Lamps

Abstract

This report is a compilation of measurements of the intensity-current-voltage characteristics of lamps of the types generally used in approach-, runway-, and taxiway-lighting systems. The results of a study of the effects of color filters on the relative intensity of the lamps are included.

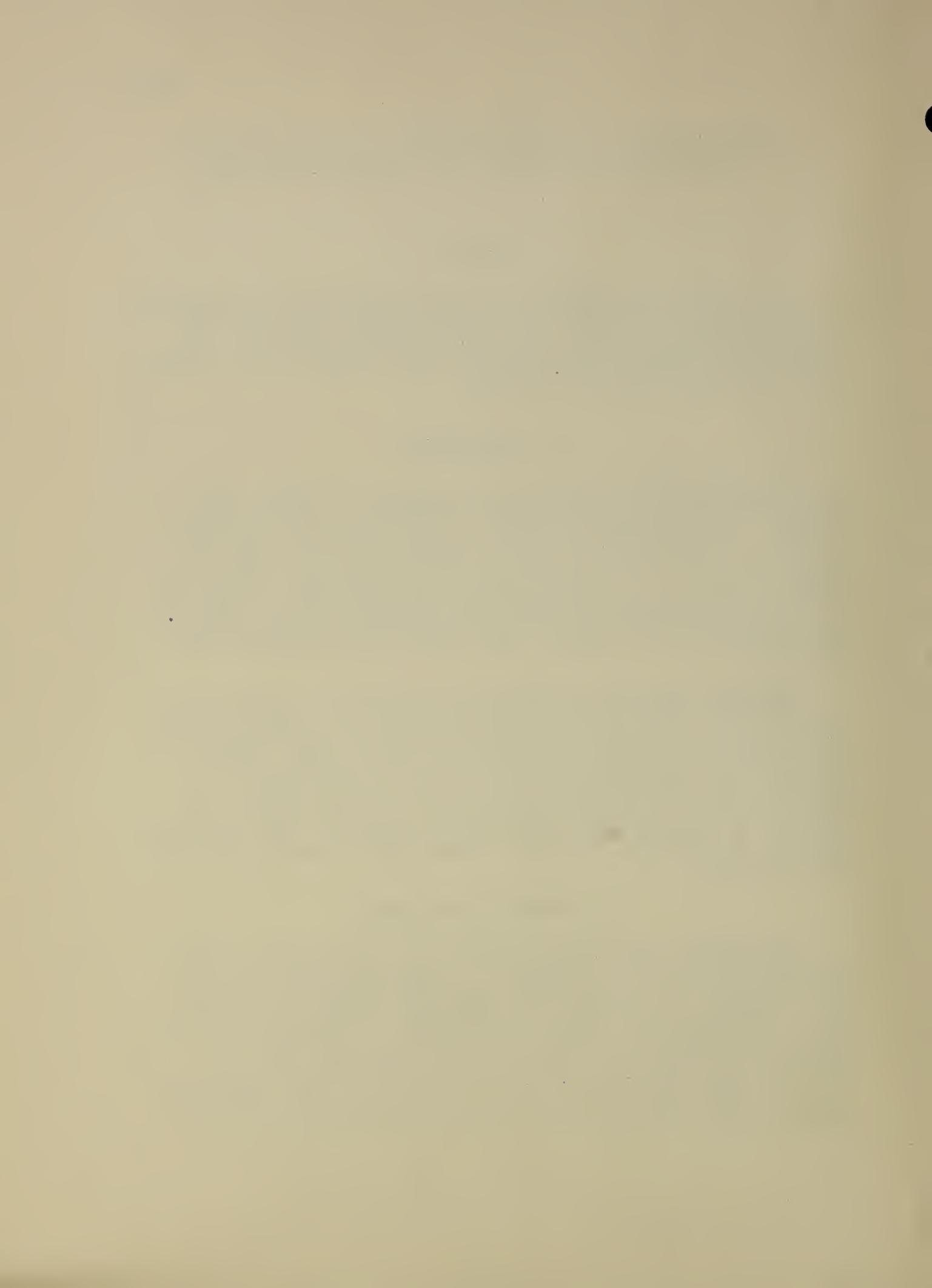
1. INTRODUCTION

Intensity control is now used on nearly all runway- and approach-light systems and is being considered for taxiway-light systems. The increasing complexity of the problems of intensity control has increased the need for information on the relative intensity characteristics of lamps used in approach, runway, and taxiway lighting as a function of the applied current or voltage. In addition, information on the effect of color filters upon the relative intensity is needed. This report was prepared to meet this need.

Relative intensity is defined as the ratio in percent of the intensity of a lighting unit or lamp operated at a stated current or voltage to the intensity of the same unit or lamp operated at rated current or voltage. Note that in obtaining the relative intensity of a colored light, measurements of the intensity at both the stated current (or voltage) and the rated current (or voltage) are made with the color filter in place. Thus, the transmittance of the filter has only a second-order effect on the relative intensity.

2. METHOD OF MEASUREMENT

Measurements of relative intensity were made using a color-corrected barrier-layer photocell in a zero-resistance circuit. The response of this photometric system was checked. No significant deviations from linearity were found. When reflector-type lamps were tested, the center of the beam was directed at the photocell. The relative intensities of lamps other than the reflector type (325-lumen, 200-watt, T-14, etc.) were obtained by measuring the relative horizontal intensity in a given direction. Previous tests have shown that the relative intensity of clear



units in which these lamps are used does not differ significantly from the relative horizontal intensity of the lamp used. Voltage and current measurements were corrected for losses in the measuring circuits. Whenever possible several lamps of a given type were used. The results of the measurements of individual lamps were averaged.

3. LAMP CHARACTERISTICS

For convenience in use, the characteristics of each lamp (except for the 250-watt lamps) are given as three curves, a, relative intensity-current; b, relative intensity-voltage; and c, voltage-current. Curves for lamps with similar characteristics have been grouped on the same figures. The lamp types studied and the figures showing their characteristics are listed in table I.

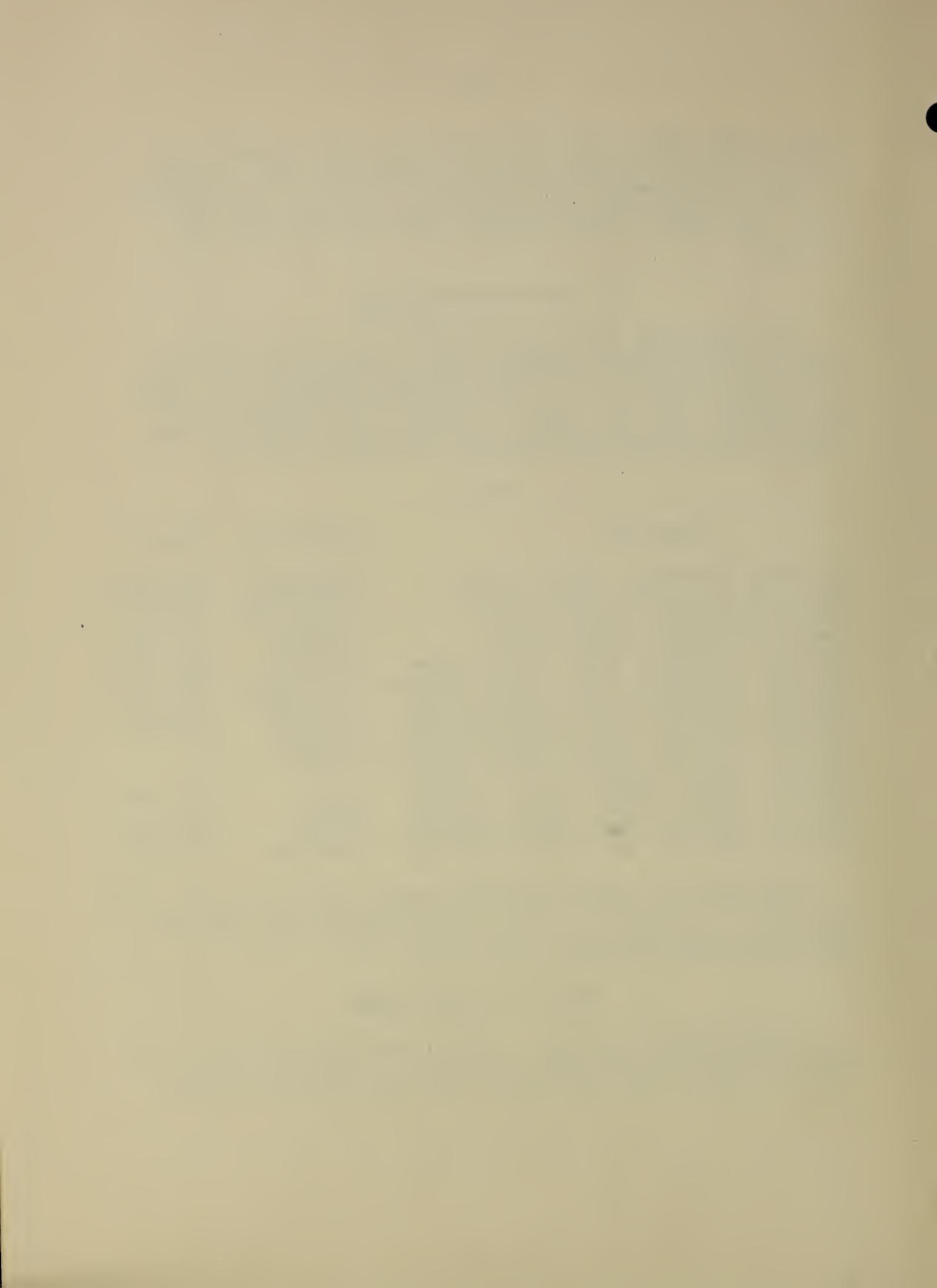
Table I

Lamp Type	Designation	Figure
325-lumen, 6.6-ampere, airport marker	325/66/A21	la, b, and c
1020-lumen, 6.6-ampere, airport marker	1020/66/A21	la, b, and c
30-watt, 6.6-ampere, airport marker	6.6A/T10/1P	la, b, and c
45-watt, 6.6-ampere, airport marker	6.6/T10P	la, b, and c
200-watt, 6.6-ampere, T-14, airport marker	6.6A/T14P	2a, b, and c
200-watt, 6.6-ampere, PAR56, airport approach	6.6A/PAR56/2	2a, b, and c
500-watt, 6.6-ampere, T-20, airport marker	6.6A/T20P	3a, b, and c
500-watt, 20-ampere, T-20, airport approach	20A/T20/5	4a, b, and c
250-watt, 12.5-volt, T-10, airport approach	20A/T10/P	5
250-watt, 12.5-volt, PAR56, airport approach	250PAR	5
300-watt, 25-volt, PAR56, airport approach	---	6a, b, and c
350-watt, 25-volt, PAR56, airport approach	350PAR	6a, b, and c
399-watt, 115-volt, PAR56, airport approach	399PAR	7a, b, and c
500-watt, 120-volt, T-20, airport approach	500T20/25	7a, b, and c

Differences in relative intensity between lamps of the same type may become large when the relative intensity becomes less than 1%. The relative intensities may differ by as much as a factor of 2 when the relative intensity is about 0.2%.

4. EFFECTS OF COLOR FILTERS

Because the transmittance of color filters is a function of the color temperature of the source, the relative intensity characteristics of colored lights will differ from those of similar lights



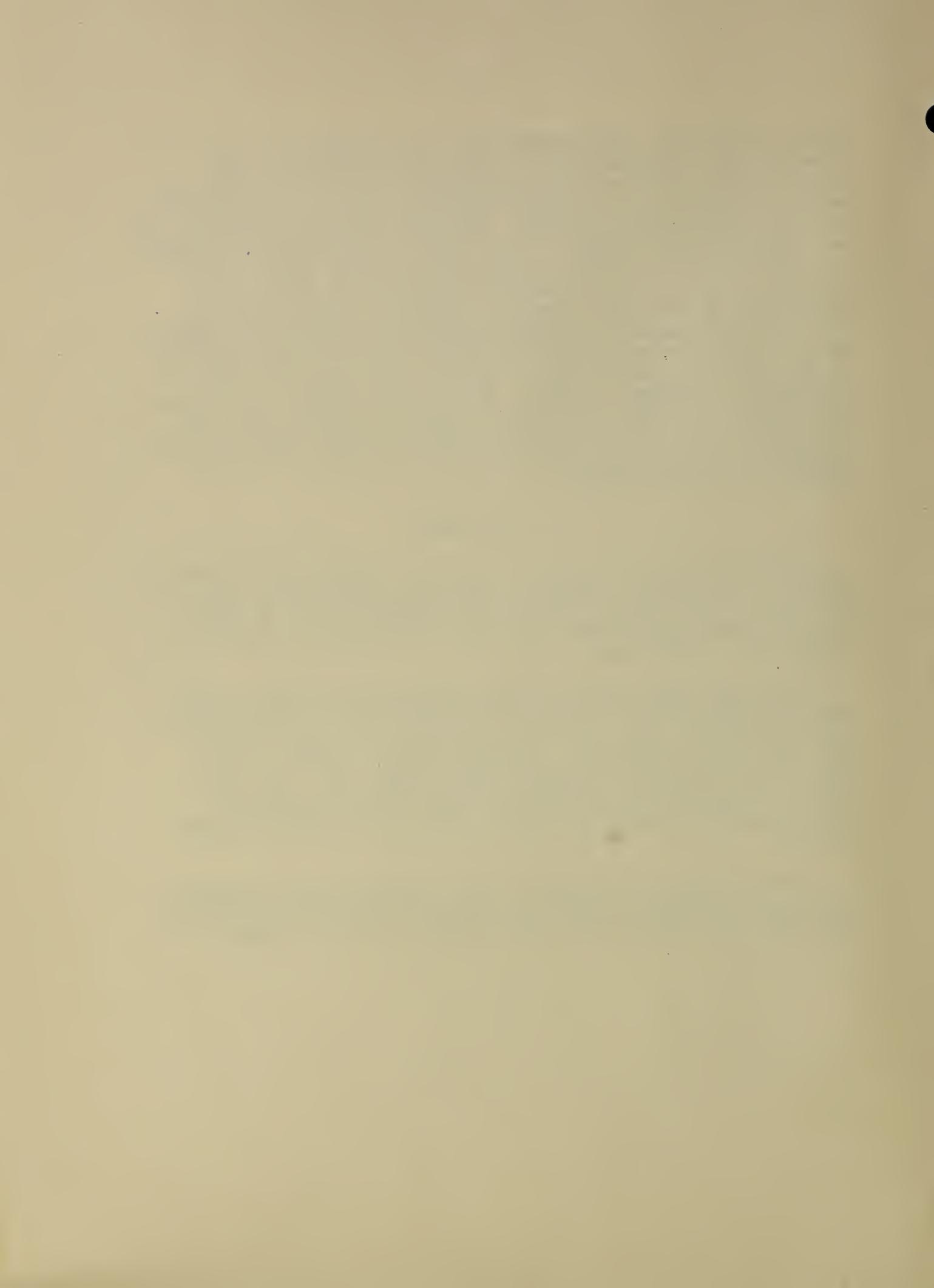
which are "white". The determination and presentation of the relative intensity characteristics of each type of lamp for each aviation color would be unduly expensive. Therefore, a study was made to determine representative correction curves, in case the use of these curves proved feasible. Relative intensity characteristics were determined for several of the types of lamps listed in table I in combination with filters representative of the limits of the aviation colors. It was found that the data were adequately represented by the lines plotted on figure 8. These lines show the relative intensity of lights meeting the specification requirements for aviation colors as a function of the relative intensity of the same light used without a filter. The lines are representative of "average" filters. The relative intensity of lights with filters near the specification limits may differ from that indicated by the lines by about ten percent at the lowest relative intensities shown. The difference will, of course, be less at higher relative intensities.

5. DISCUSSION

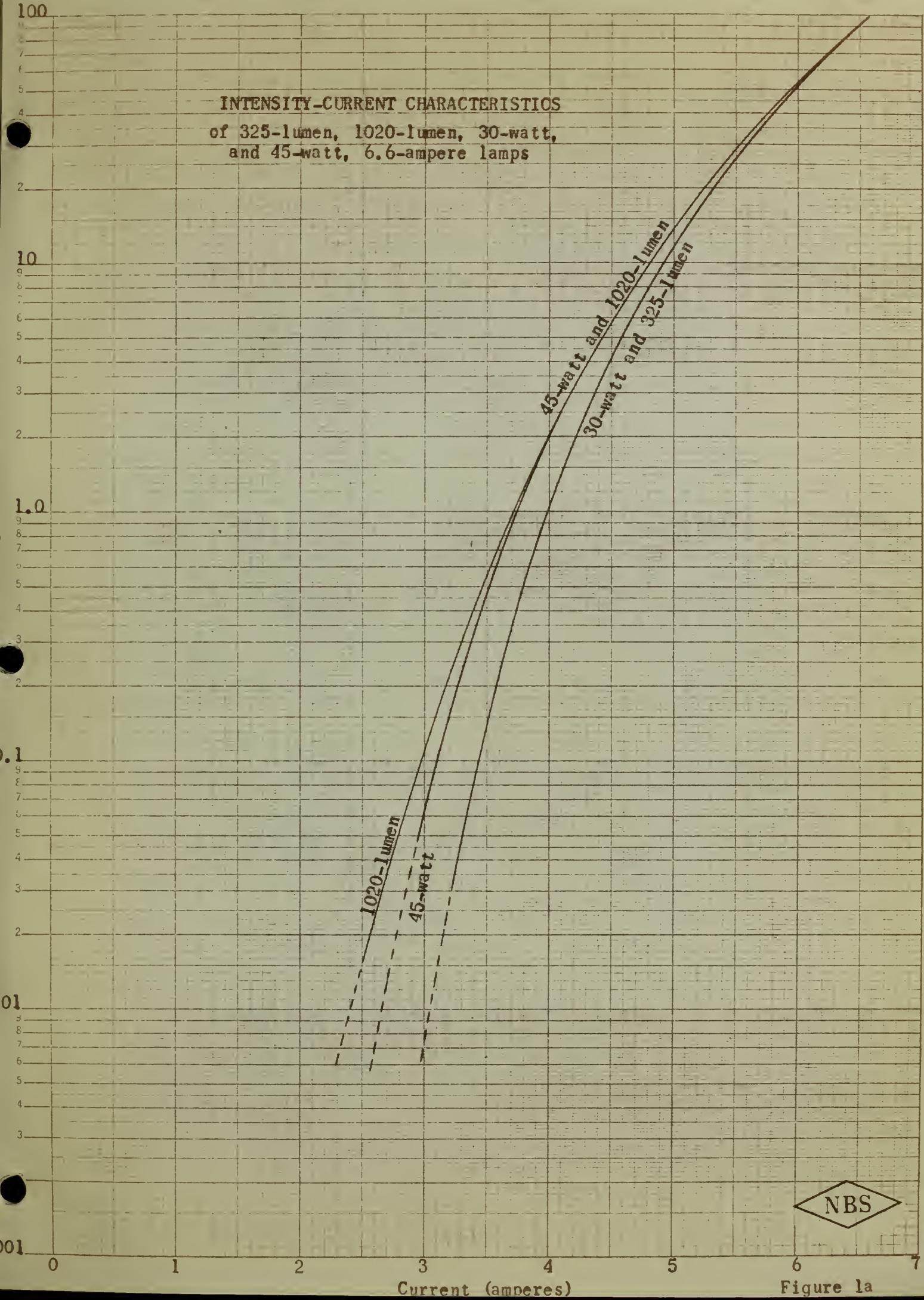
Differences in the change of relative intensity with change in current or voltage for different lamps are significantly large so that generalized lamp-characteristic exponents cannot be satisfactorily used for all lamp types when the relative intensity is varied over a wide range.

For lamps with the same rated current and of similar design wattage (within 25%), the relative intensity-current characteristics are similar. See the curves on figure 1a. Also compare the curves for the 200-watt, 6.6-ampere lamps, figure 2a, with those of the 500-watt, 6.6-ampere lamp, figure 3a. The data shown on figures 6b and 7b indicate that relative intensity-voltage characteristics are similar for lamps of similar design wattage.

The data shown on figures 2a and 5 indicate that the characteristics of reflector-type lamps are not significantly different from other lamp types of the same rated wattage and voltage.

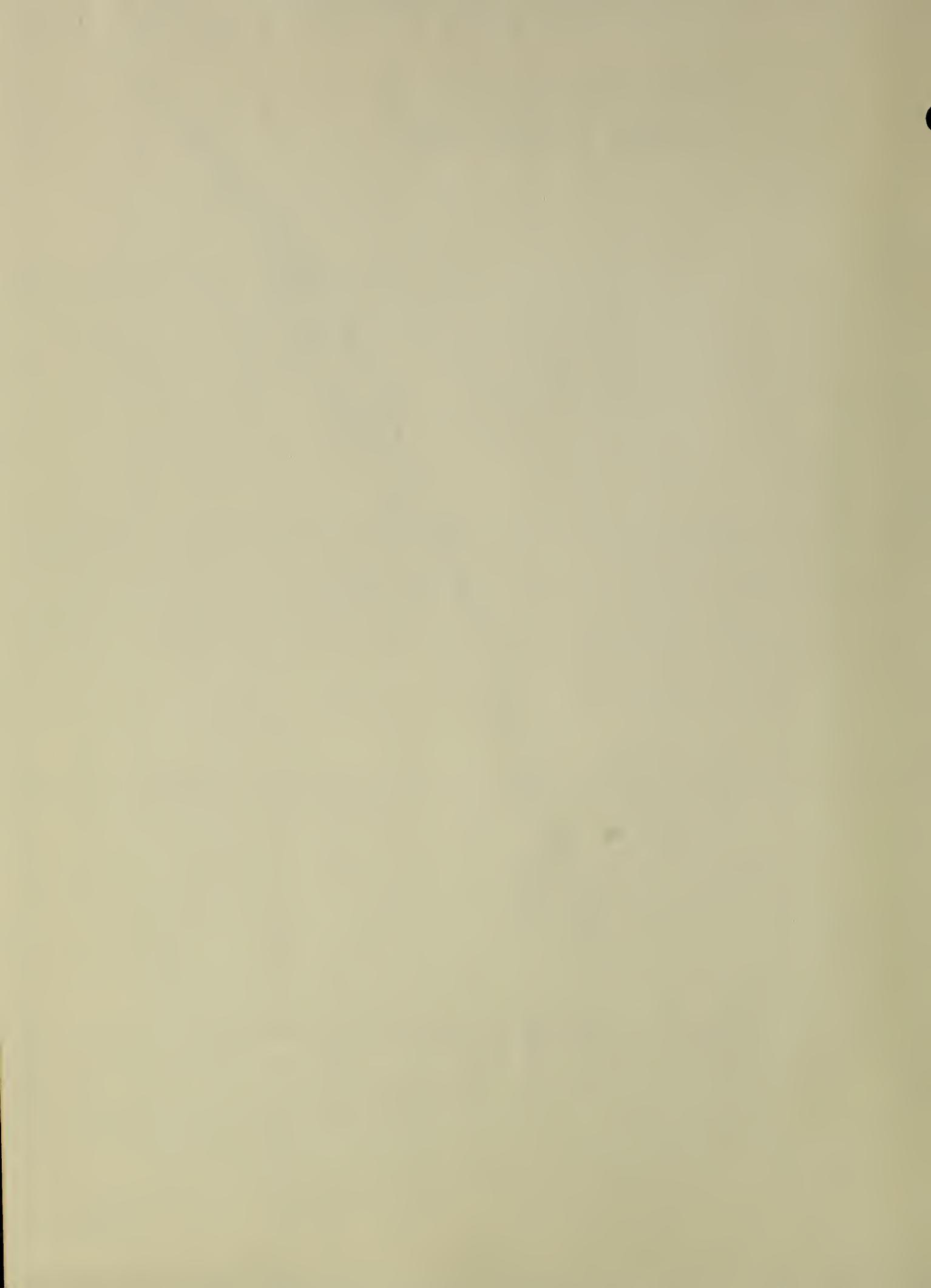


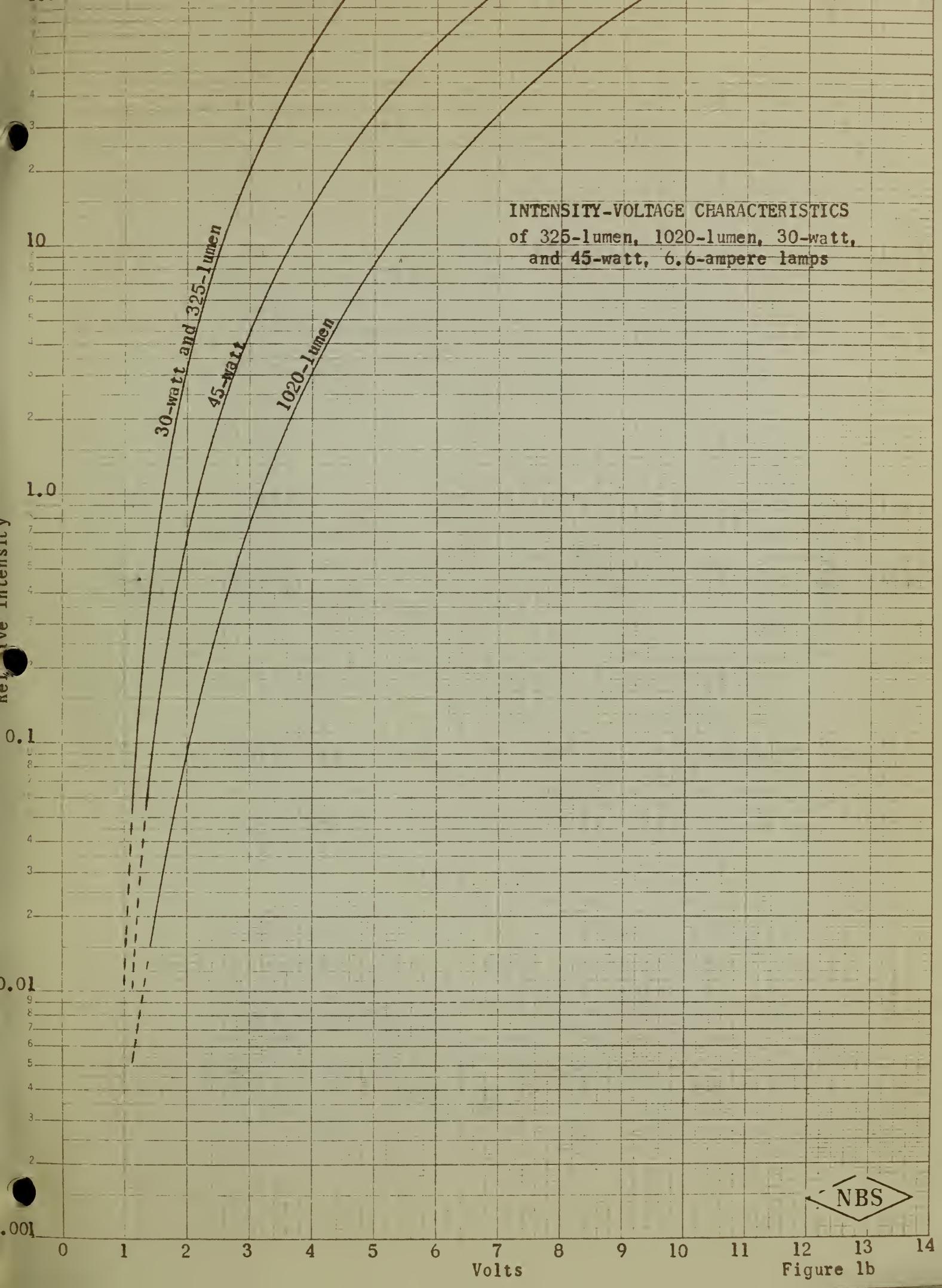
INTENSITY-CURRENT CHARACTERISTICS
of 325-lumen, 1020-lumen, 30-watt,
and 45-watt, 6.6-ampere lamps



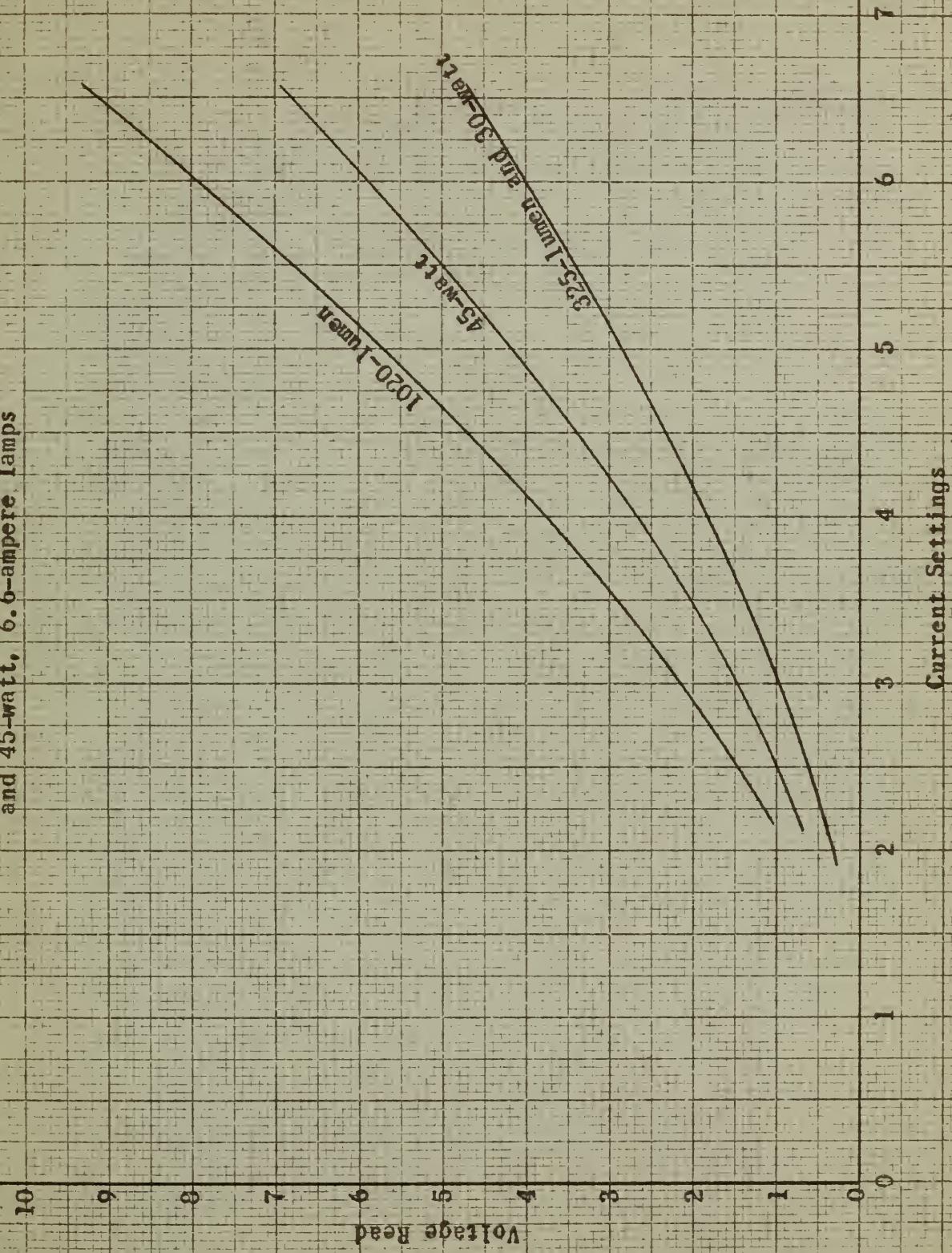
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Figure 1a





CURRENT-VOLTAGE CHARACTERISTICS
of 325-1 lumen, 1020-lumen, 30-watt,
and 45-watt, 6.6-ampere lamps



Current Settings

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Figure 1c

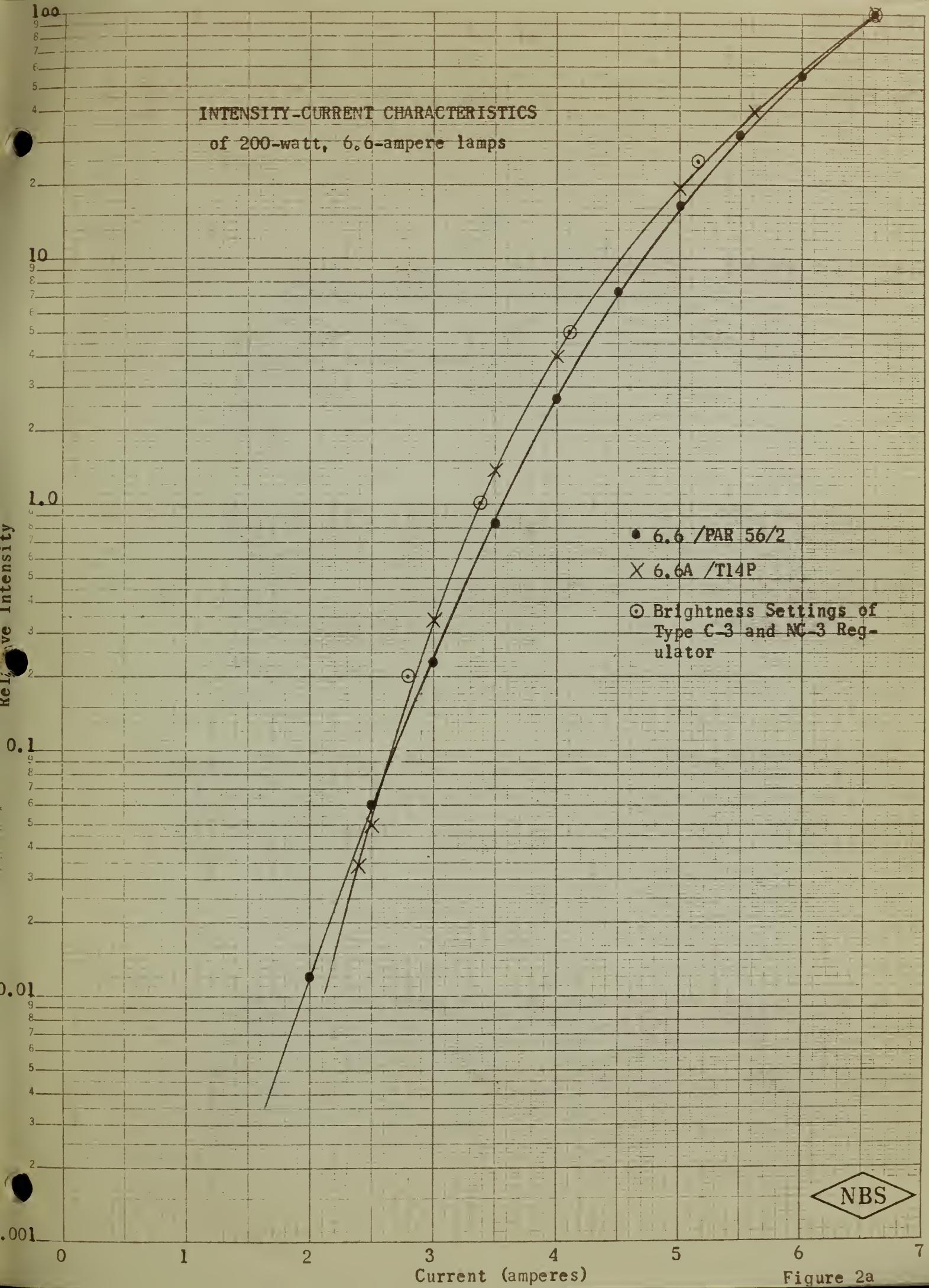
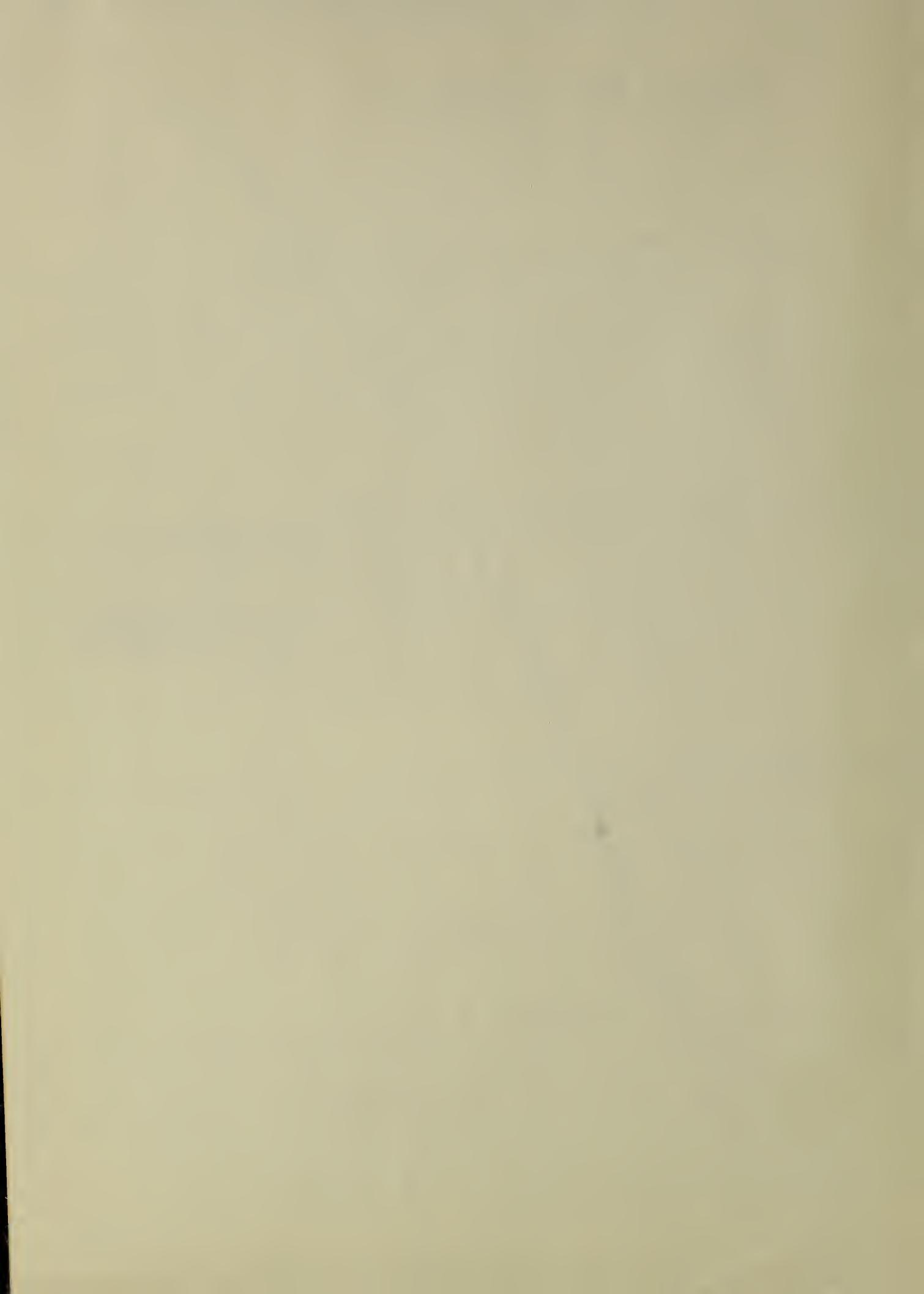
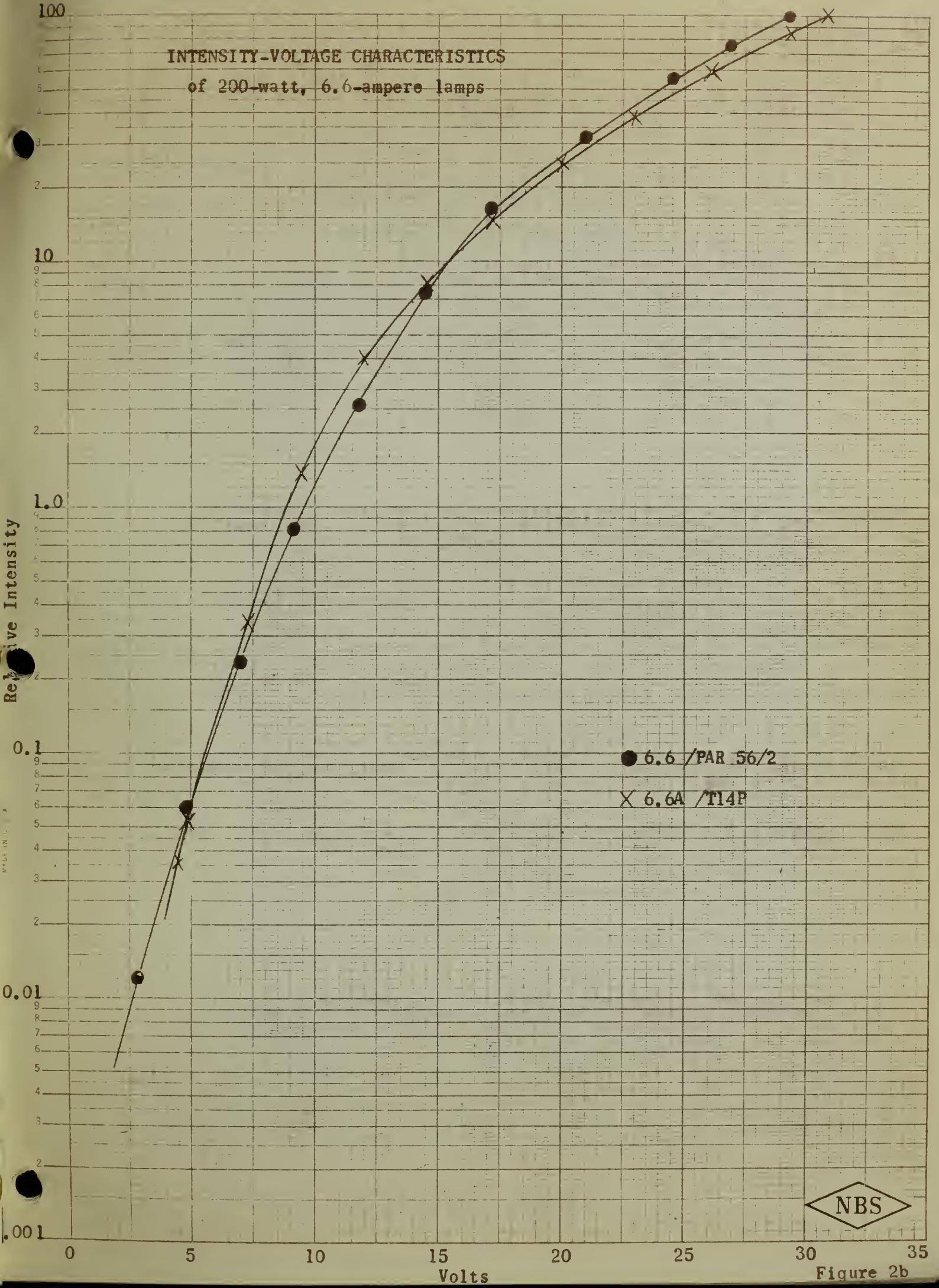
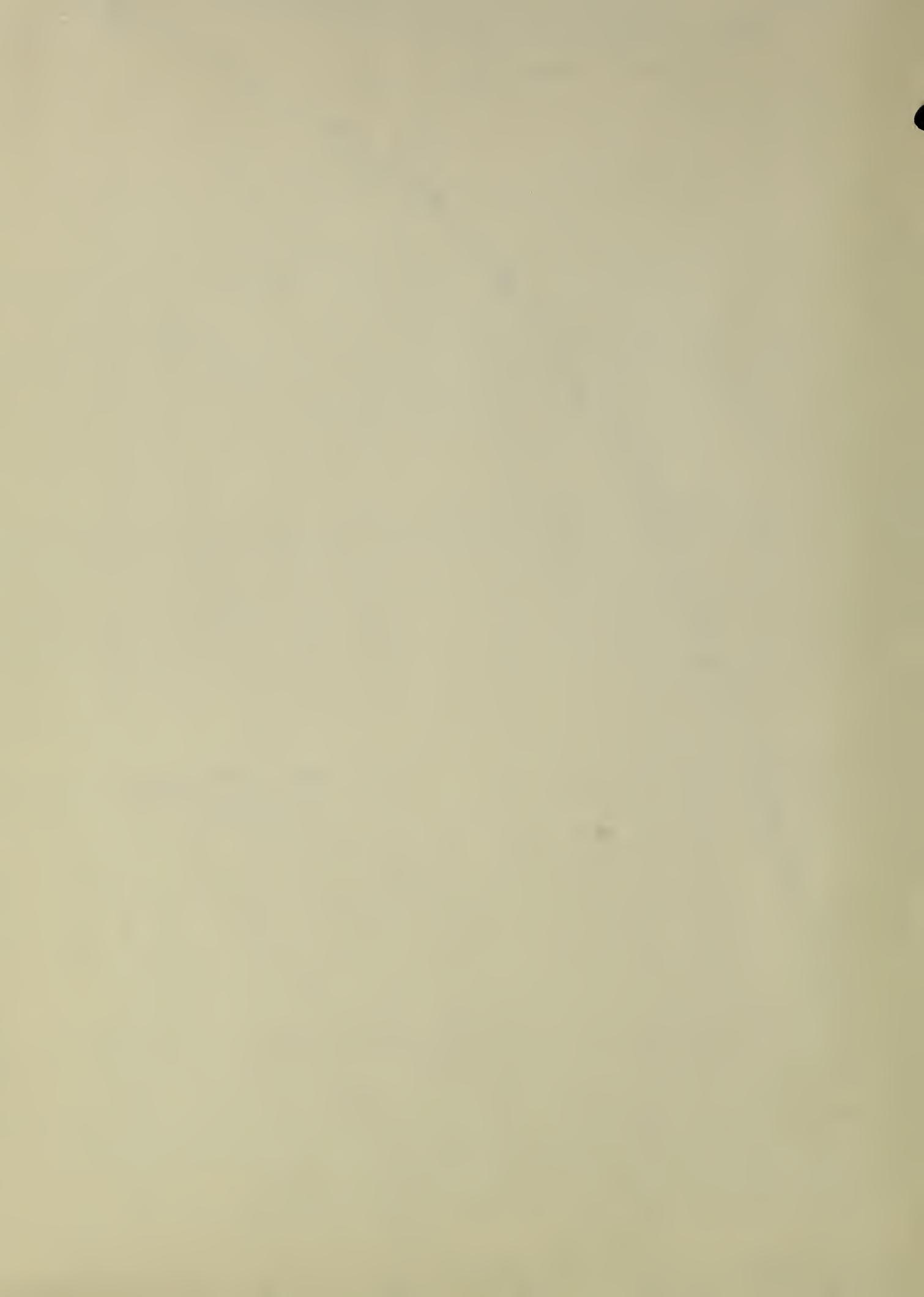


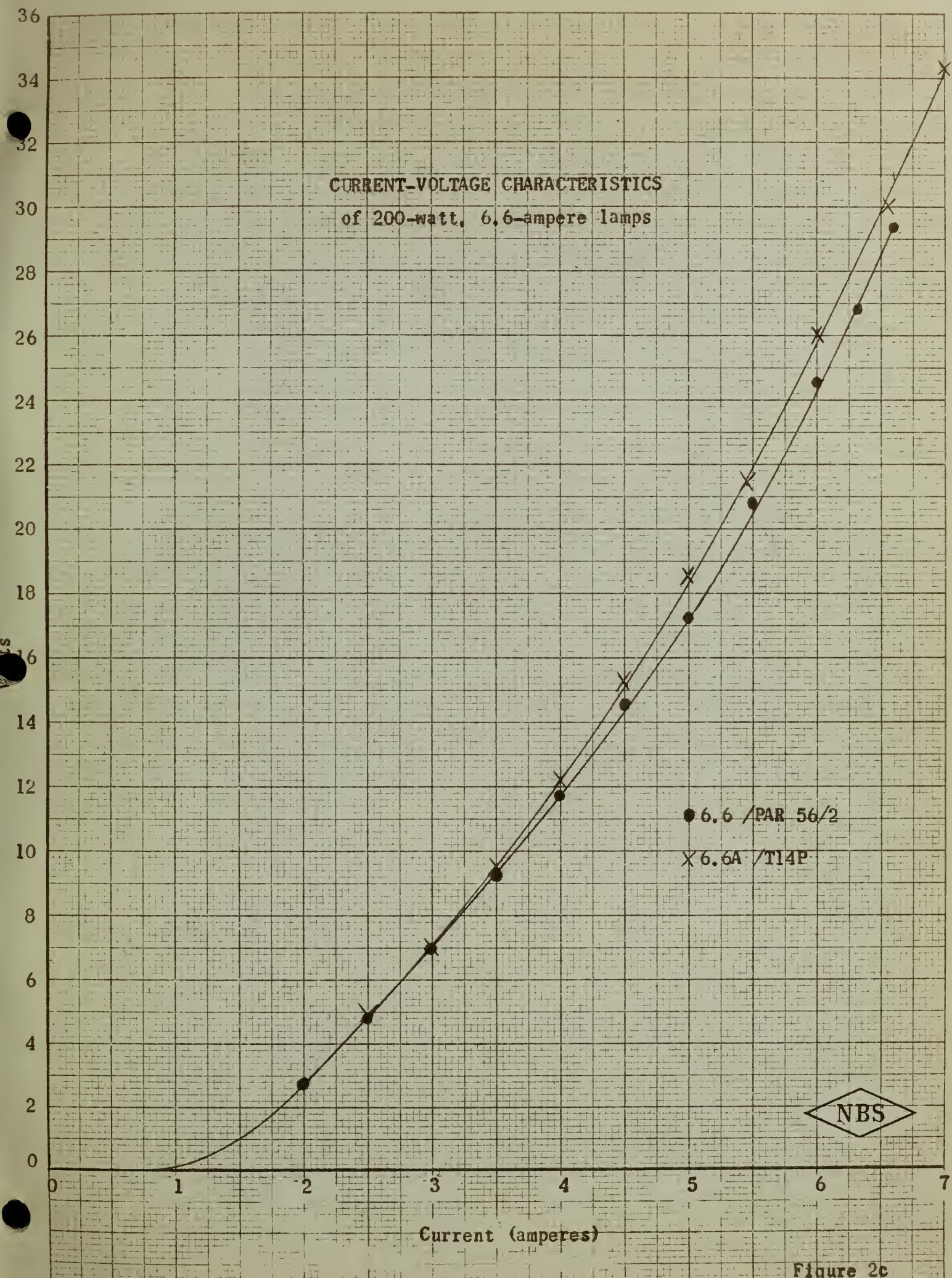
Figure 2a





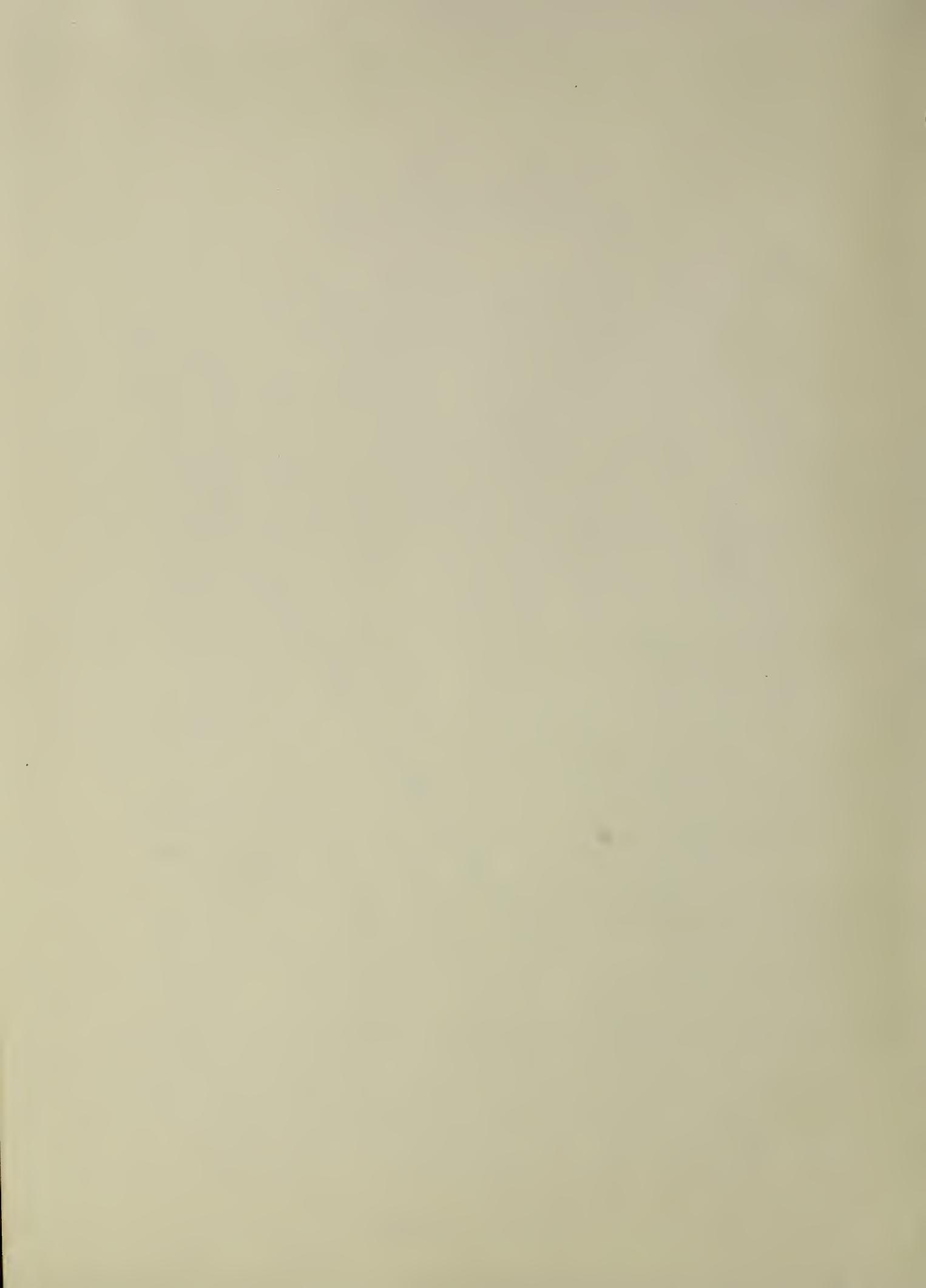


CURRENT-VOLTAGE CHARACTERISTICS
of 200-watt, 6.6-ampere lamps



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Figure 2c



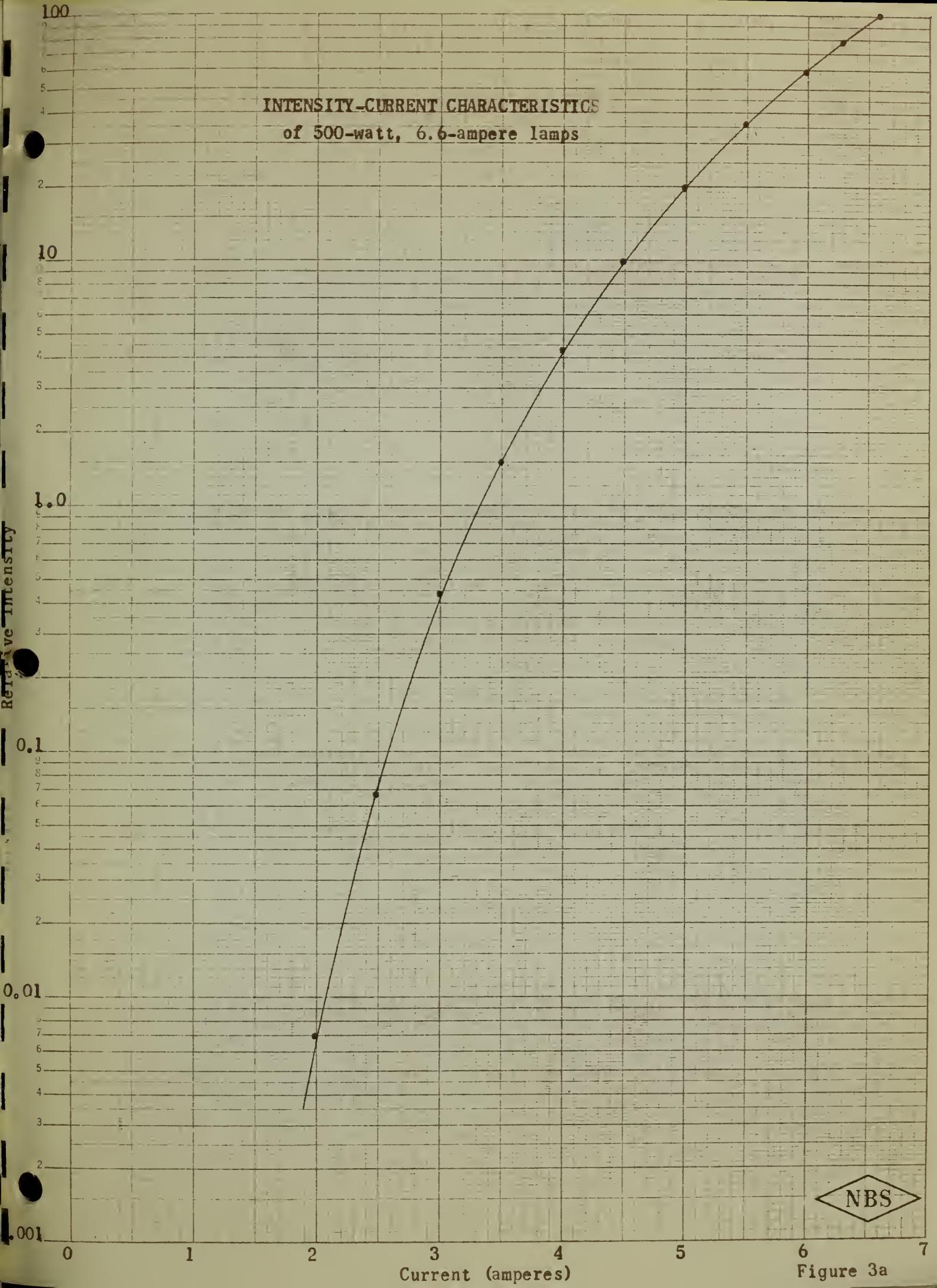
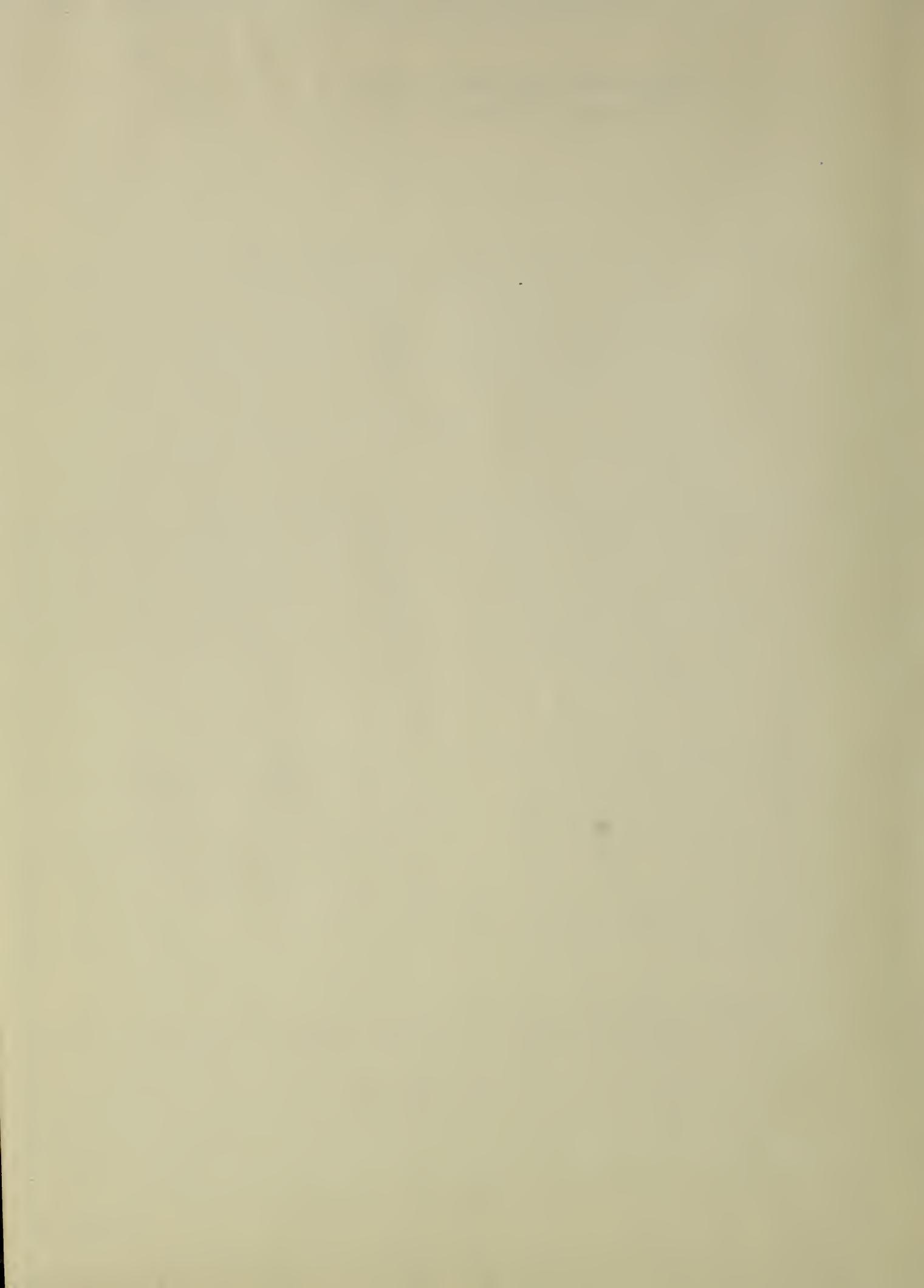


Figure 3a



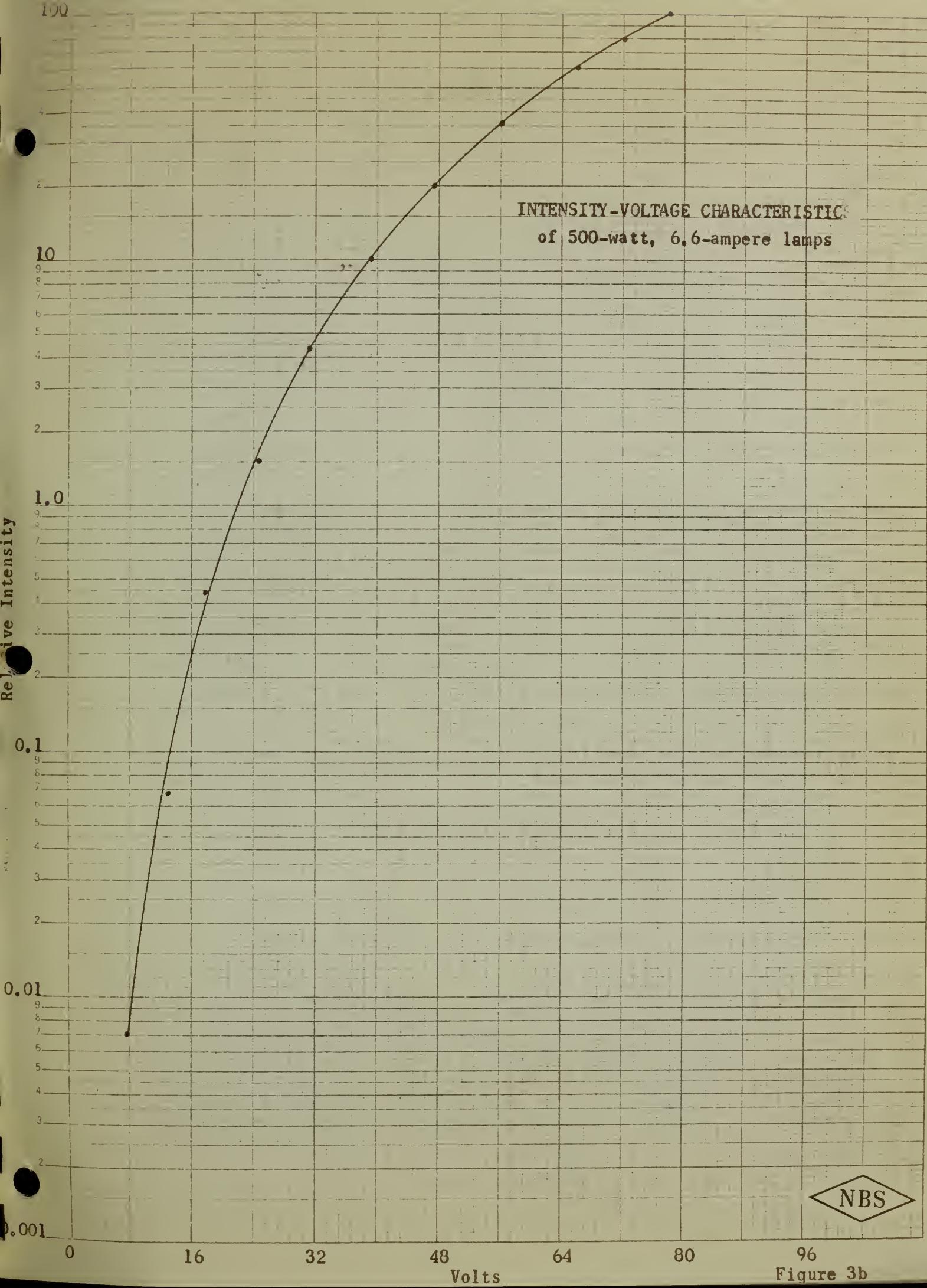


Figure 3b

CURRENT-VOLTAGE CHARACTERISTIC
of 500-watt, 6.6-ampere lamps

Volts

80

70

60

50

40

30

20

10

0

1

2

3

4

5

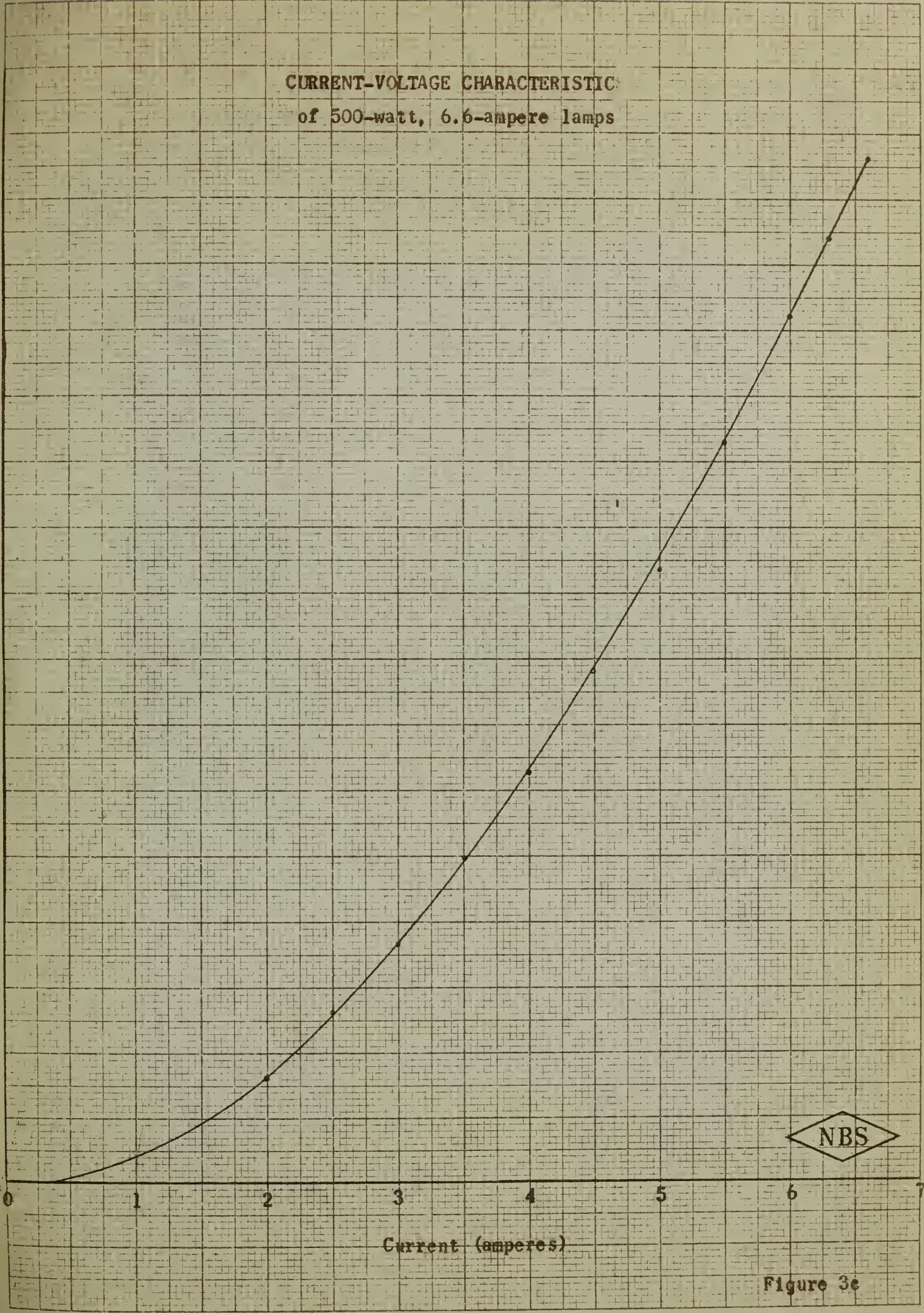
6

7

Current (amperes)

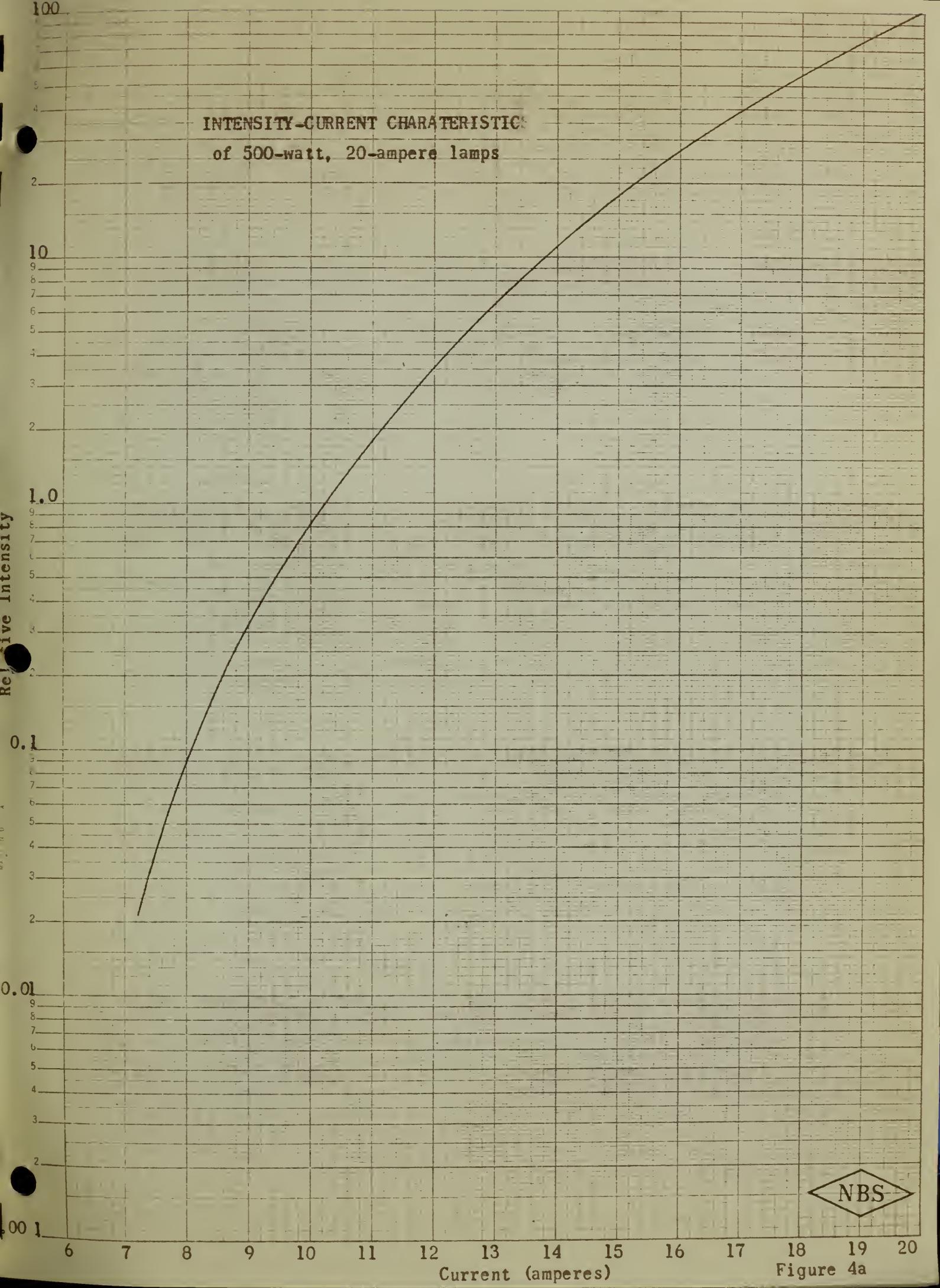
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Figure 3c





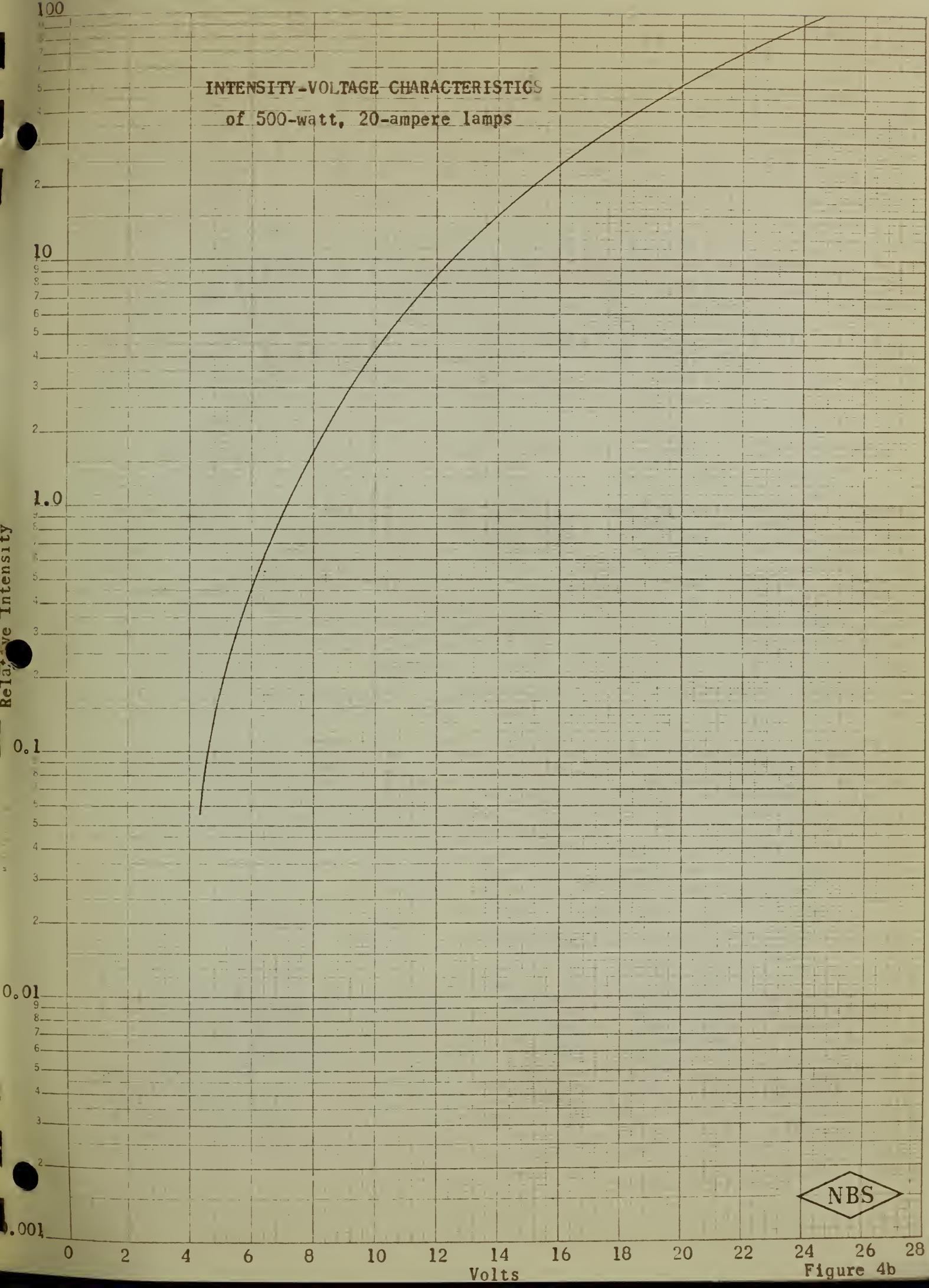
INTENSITY-CURRENT CHARACTERISTICS
of 500-watt, 20-ampere lamps



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Figure 4a

INTENSITY-VOLTAGE CHARACTERISTICS
of 500-watt, 20-ampere lamps



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Figure 4b



24

22

20

18

16

14

12

10

8

6

4

2

0

Volts

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Current (amperes)

CURRENT-VOLTAGE CHARACTERISTIC
of 500-watt, 20-ampere lamps



Figure 4c

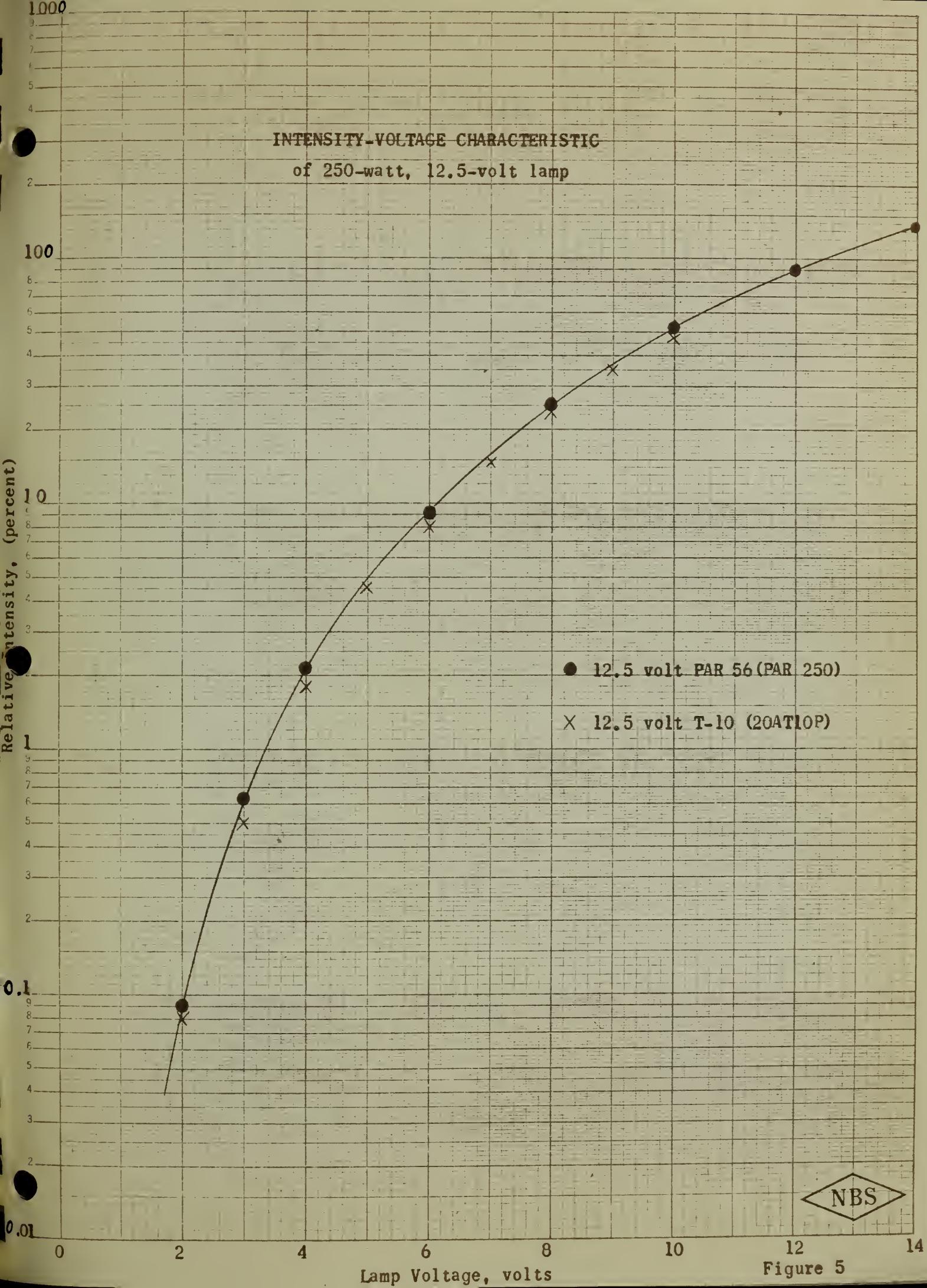
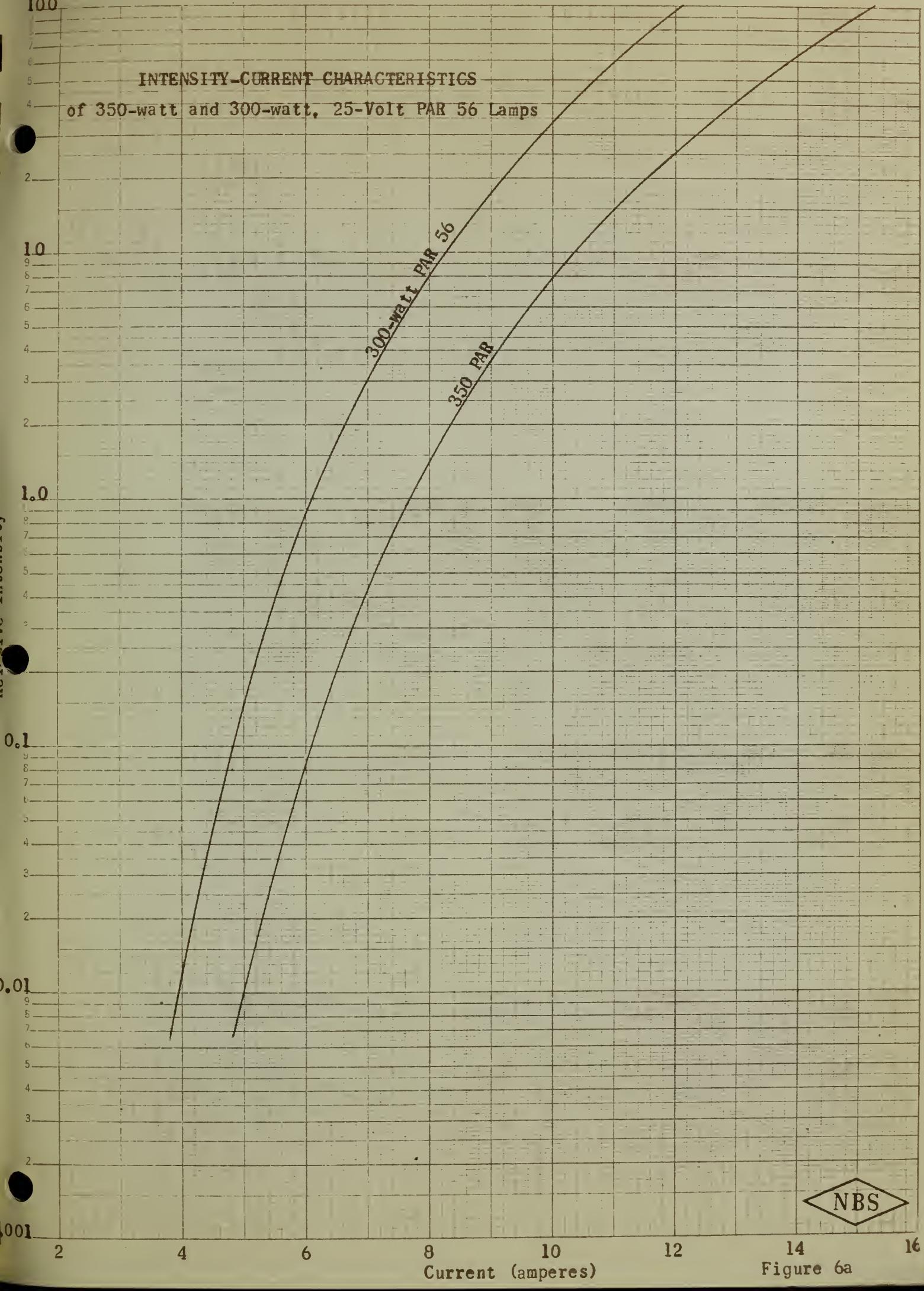


Figure 5

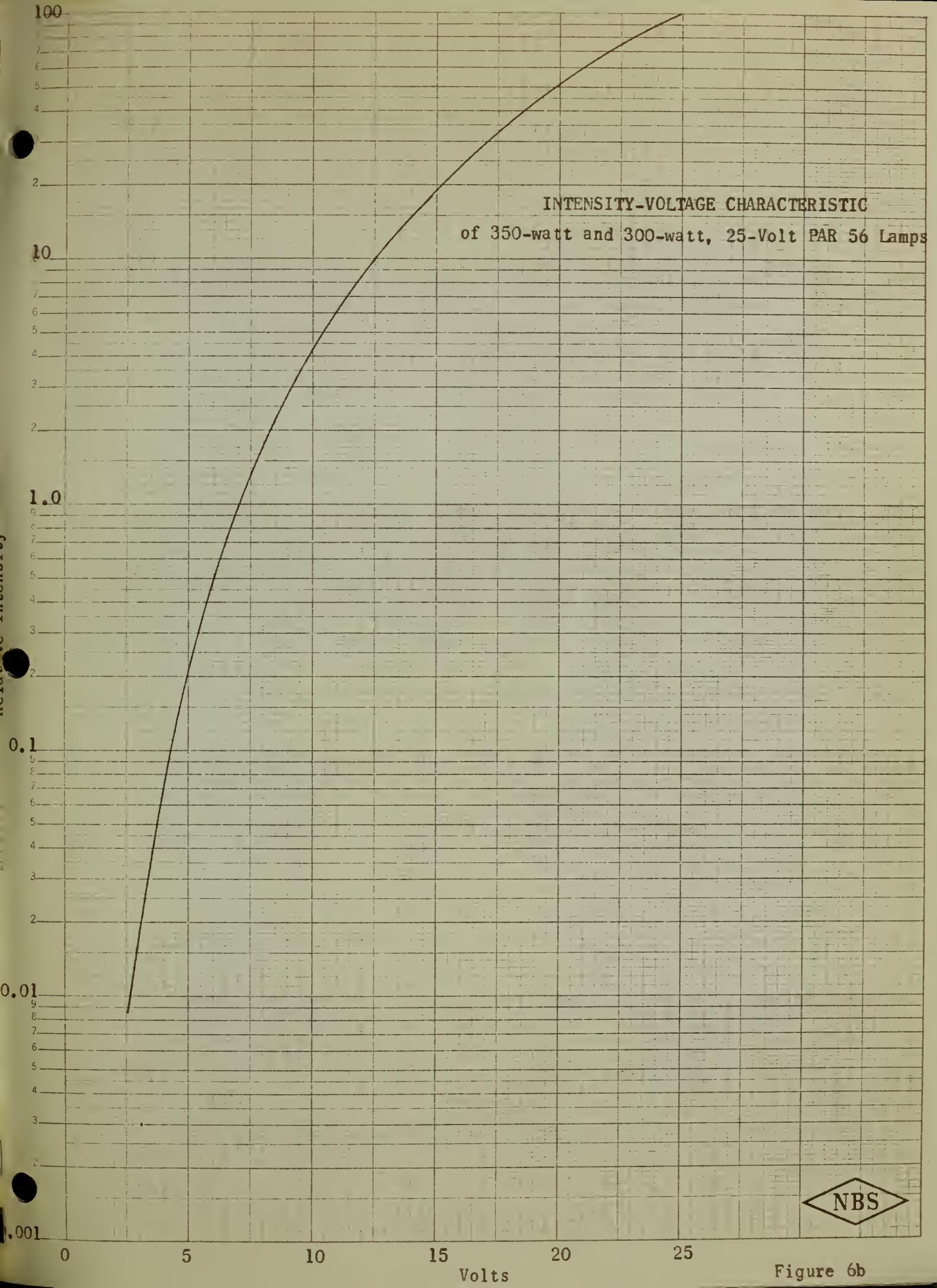
INTENSITY-CURRENT CHARACTERISTICS

of 350-watt and 300-watt, 25-Volt PAR 56 Lamps



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Figure 6a

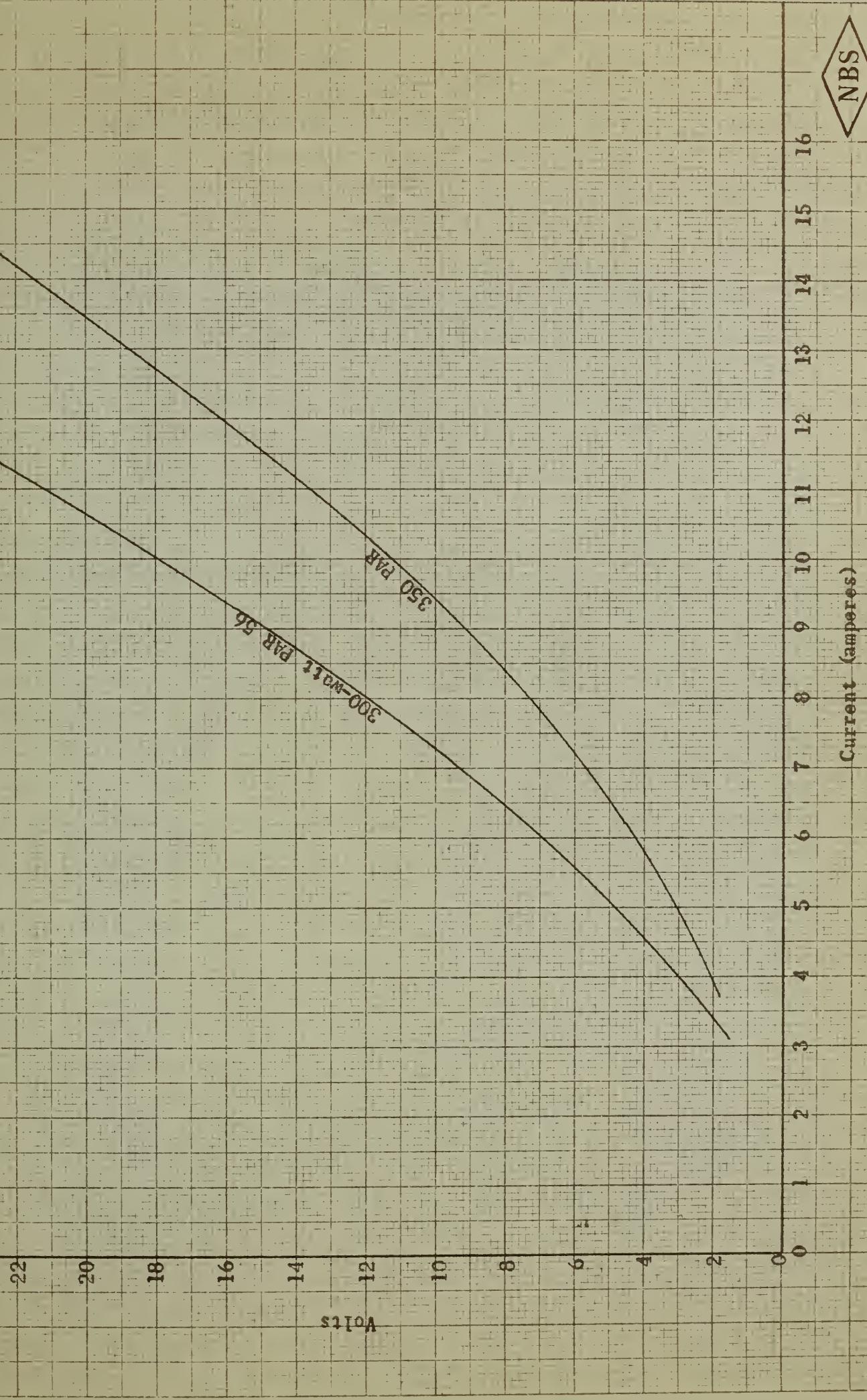


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Figure 6b

CURRENT-VOLTAGE CHARACTERISTICS

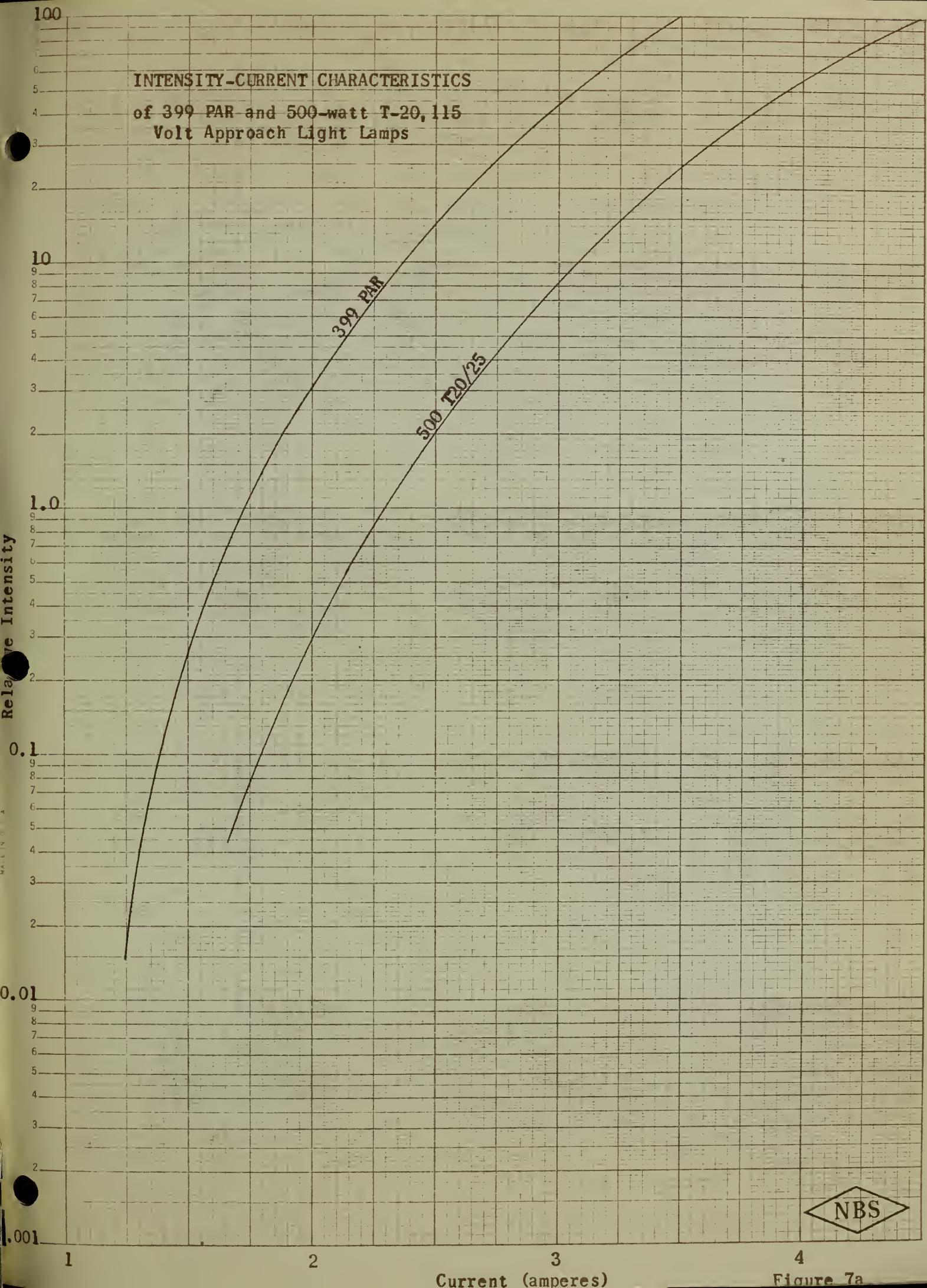
of 350-watt and 300-watt, 25-Volt PAR 56 Lamps



Current (amperes)

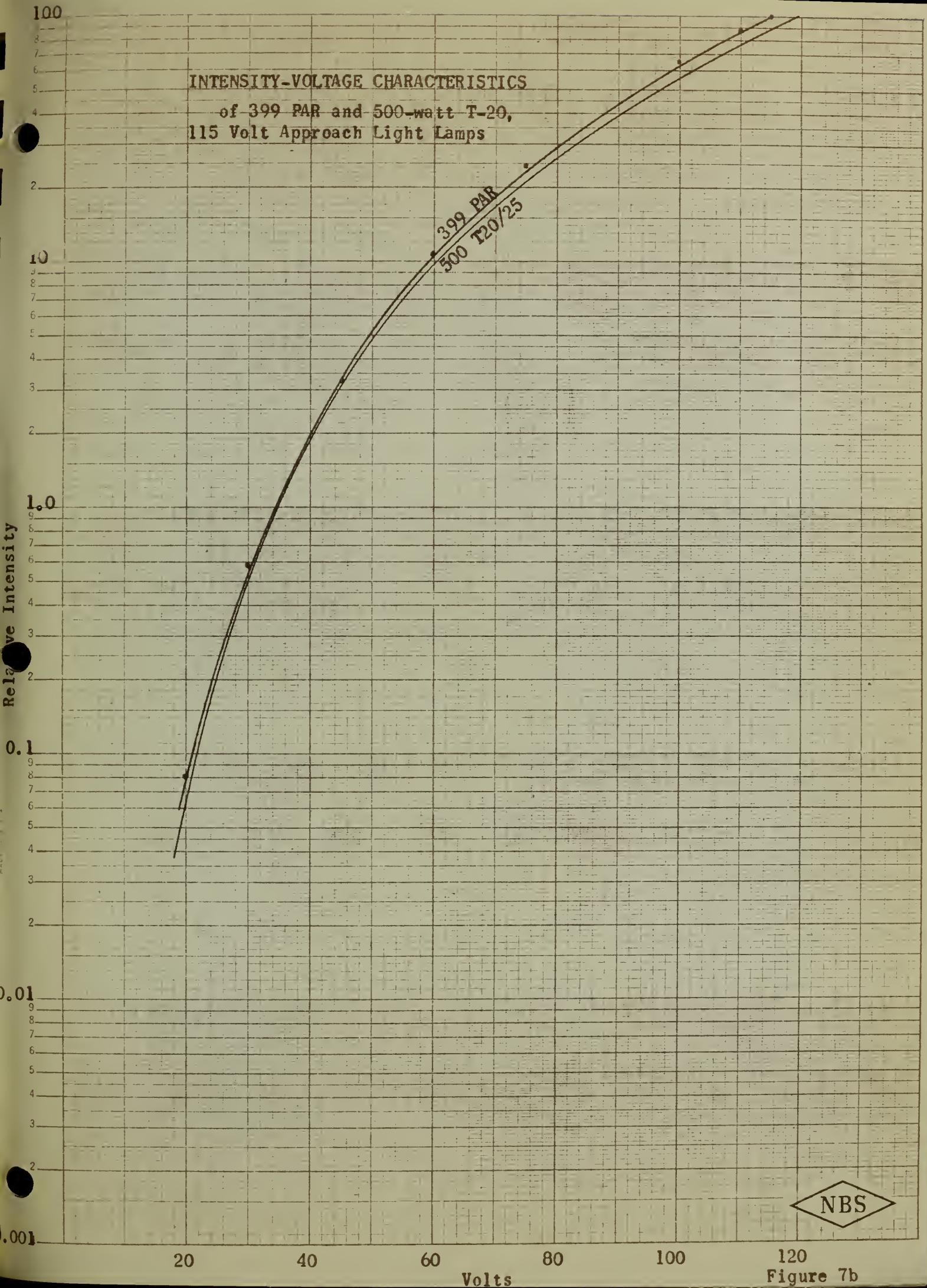
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Figure 6c



NBS

Figure 7a

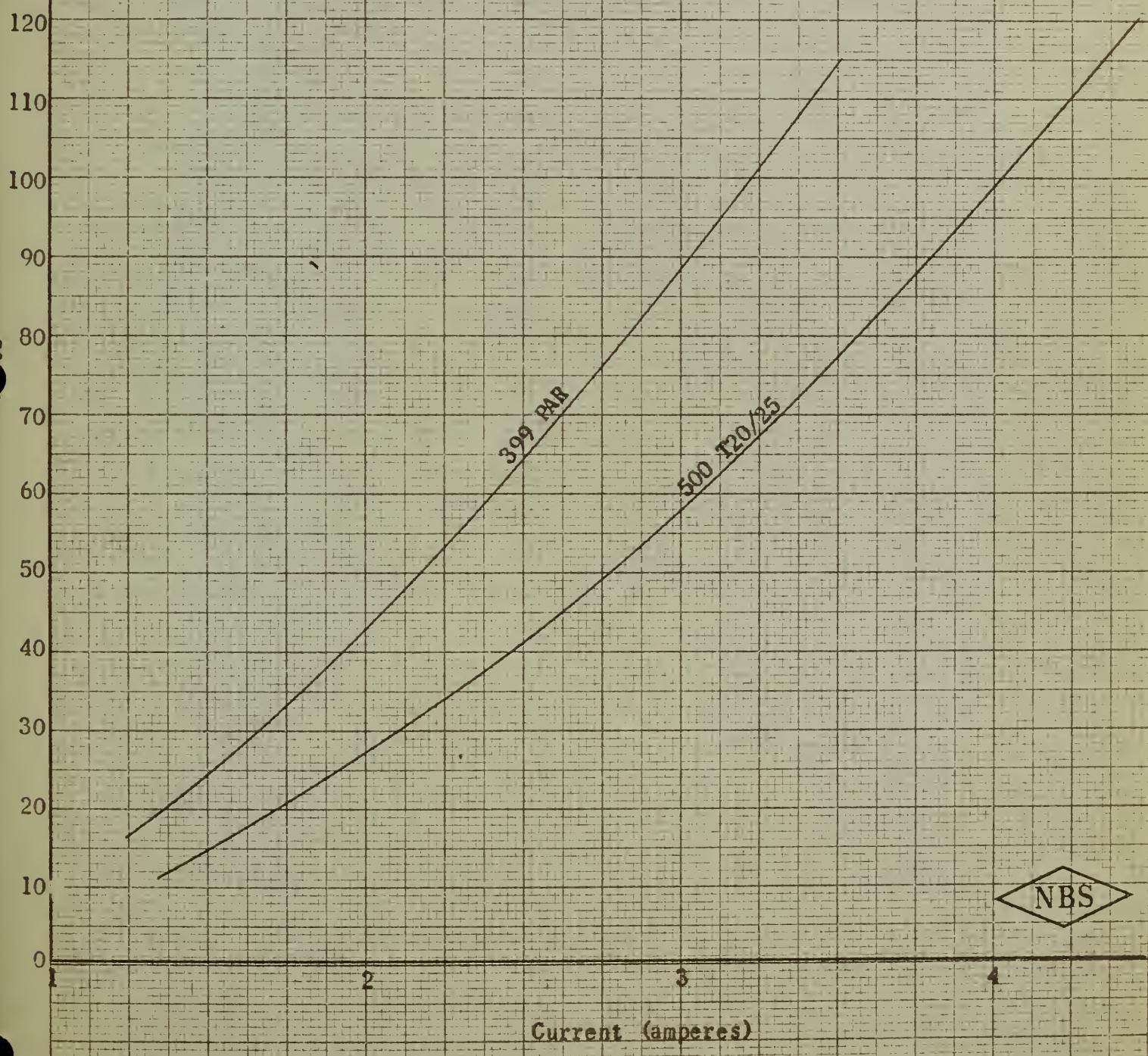


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Figure 7b

CURRENT-VOLTAGE CHARACTERISTICS

of 399 PAR and 500-watt T-20,
115 Volt Approach Light Lamps



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Figure 7c

RELATIVE INTENSITY OF COLORED LIGHTS

10

1.0

1

RED
YELLOW
GREEN
BLUE

2 3 4 5 6 7 8 10.0

2 3 4 6 7 8 9 10

2 3 4 5 6 7 100

Relative Intensity of "White" Light

Figure 8

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